Gearbox Overhaul - Part 1

We describe the disassembly of a TR250-TR6 gearbox in another technical note. The following describes how an amateur mechanic can successfully (we hope) overhaul a gearbox and put it back together. The same parts nomenclature as The Roadster Factory TR6 and TR250 Catalogues is used. These catalogues have excellent diagrams showing how the parts are assembled on the shafts and should be used in conjunction with the following description.

You might recall from the previous article that the object was to overhaul a TR250 gearbox with A Type overdrive. When the gearbox was examined the ***constant gear*** (the big gear on the front of the countershaft that mates with the gear on the input shaft) was found to have some broken teeth. A spare early TR6 non-overdrive gearbox was also available. It was that spare gearbox that was disassembled in the previous article to get good gears for the overdrive gearbox. The only difference between an overdrive and a non-over drive gearbox is the mainshaft; the overdrive gearbox uses a shorter mainshaft that mates with the overdrive unit that is installed in place of the gearbox rear extension. The plan had been to use all the gears from the TR6 gearbox and only use the shorter mainshaft from the TR250 gearbox.

Differences in early gearboxes

After the TR6 gearbox was disassembled and the parts compared with those from the TR250 gearbox, two big differences were noted. The first difference is the length of the needle bearings used in the countershaft assembly; the later design uses a slightly longer bearing. After researching parts supplied by TRF and Moss, it was found that both now supply the later bearing for both applications. The TRF parts book explains that the beveled washers in the earlier countershaft should be left out to make room for the longer bearing.

The second difference is the bearing and associated mating surfaces between the input shaft and the mainshaft. The earlier design uses a pressed-in needle bearing whereas the later design uses a slide-in needle design. Since the diameters of the part of the main shaft that mates with the input shaft is different between the earlier and later designs, the earlier mainshaft (this is the short mainshaft used with an overdrive and in this case had a pressed-in bearing) couldn't be used with a later input shaft designed for slide-in bearing.

The gearboxes in this project have serial numbers CD7371 and CD24638. The Moss catalog indicates that the change in mainshaft design was made around gearbox CD20281. This was a bit of a dilemma since the early input shaft (which has the gear that drives the countershaft gear) must be used with a mating countershaft gear from the later gearbox because the countershaft gear from the earlier gearbox has the broken teeth. The gears were examined closely and all seemed to have the same tooth design. This is supported by data in the TRF catalog. The only problem is that the input shaft and the mating constant gear on the countershaft were always supplied as a matched pair. Since the old input gear and newer countershaft gear seem to mate perfectly they were called a new pair---rationalizing that since both are worn a bit they should work fine together. (The same can be said for some older folks.)

Note: I'm in the market for a cheap pre CD20281 TR250/TR6 gearbox with good gears ---- I'm collecting spare parts.

Replacement Parts

The overhaul consists of replacing all bearings, synchronizer cups, mainshaft seals and some thrust washers. A TRF Gearbox Overhaul Kit had been purchased for the project. The kit contains the following parts:

- 3 mainshaft bearings
- Front and rear seals
- 2 countershaft bearings with circlips
- Front and rear countershaft thrust washers
- Countershaft locking plate with screw
- 4 synchronizer cups
- Gasket set
- That nasty mainshaft clip retaining third gear

The prices of individual parts weren't checked to see if they discount the parts if purchased in the kit. However, in many cases, all the parts are not needed. The rear mainshaft bearing isn't used if you have an overdrive. (The OD unit uses a different bearing. Replacing the bearings in the OD unit requires special tools and was not attempted in this overhaul.)

The new synchronizer cups are probably also overkill. One should measure the distance between the cup and the associated gear with feeler gauges (next photo) and if greater that .030 inches, the cup need not be replaced. The cup should be held firmly against the gear when this measurement is taken. This measurement can be taken just as easily when the gears are off the mainshaft. For this project all the synchro cups were well within specs but were replaced anyway since there was a new set in the kit (not sure that this makes sense). The synchro cups are ~ $80 for a set of four. Next time everything in the kit except the synchro cups and rear bearing will be purchased. I have a whole stack of used cups that are well within specs.

Input Shaft Rebuild

The work on the input shaft involves replacing the bearing between the input shaft and mainshaft (pressed in the rear of the input shaft), replacing the front gearbox bearing (pressed onto the input shaft), and replacing the front seal pressed into the front-end cover (the thing over which the throw-out bearing sleeve slides). The operative word here is pressed. The ***unpressing*** is, in one case, is no easy task.

The TRF catalog says that one can identify the early input shaft design because it has a pressed-in, closed-cage bearing which is ***hard to remove***. After inspecting the bearing it seemed to be no big deal. A rag was wrapped around the front of the input shaft, which was then mounted in the vise with that difficult bearing facing up. (This shaft is literally irreplaceable; hence it is probably appropriate to wrap the shaft in a heavy bath towel. A bath towel was not available for this job because the spouse was setting between the workshop and the linen closet.)

Next, a tool was designed to catch behind the lower lip of the bearing and pull it up. It didn't work; the lower lip shattered and the needle bearings fell out while the outside race was still firmly pressed into the input shaft.

At this point it was clear that the outside race would have to be removed in pieces. Several chisels were tried with some success at breaking off pieces. It finally became obvious that a channel would have to be broken out the length of the bearing race to relieve the pressure before it could be removed. A center punch was the tool that worked. A new point had to be ground after every few whacks so that it would bite between the hardened thin outer shell of the bearing and the input shaft surface. (You don't need to worry much about scratching the inside of the input shaft; that surface is hardened and the bearing surface is part of the new bearing anyway.) Following photos show working on the bearing and the old outer shell compared to a new bearing.

The next job is to press in the new bearing without smashing it. A piece of aluminum rod was turned so that the smallest diameter just fit inside the bearing and the next bigger diameter just fit inside the input shaft. The mating surfaces were coated with grease and then the rod and hydraulic press were used to press the bearing into the shaft; see photos. One could have also left the shaft in the vise and tapped on the rod with a small hammer to insert the bearing. Note that on the later gearbox, one merely slides out the old bearing and slides in a new one.

The next job is to press the large gearbox front bearing off the input shaft and press on a new one. One way to do this is to set the shaft on a vise with the jaws open enough for the input shaft gear to slide through but narrow enough to catch the outer bearing race. One can then place an aluminum plate or piece of wood on the end of the input shaft (to avoid damaging the shaft) and then whack the plate or wood with a large hammer to drive the shaft out of the bearing. The hydraulic press was used here as shown in following photo. Be sure you remove the circlip that holds the bearing in place before you try to press off the bearing.

When installing a new bearing, one should avoid transferring lateral forces through the bearing between the inner and outer race. In this case the input shaft is being forced through the inner race so it should be pressing against the face of inner race. One can use the vise with the jaws open just enough the let the shaft clear but still let the inner race rest on the top of the jaws. The mating surfaces should be coated with grease. The shaft can then be tapped into the bearing, being sure to place a piece of wood or aluminum between the hammer and the shaft. The press was used again here as shown in following photo. The circlip is installed after the bearing is in place.

The next job is to replace the seal in the front cover. The front cover is secured in the vise (wrapped with a rag) with the seal facing up. The outside surface of the seal is then cut with a sharp chisel and part of the outside surface is then bent toward the center forming a tab. This tab is then grasped with pliers and pried out. It's a bit more difficult than one might guess from this description but much less difficult than getting that small bearing out of the input shaft. Next, the outside surface of as new seal is greased and the seal is tapped it in using a small flat ended punch against the inside front of the seal. The next photo shows installing the new seal. That is the old seal beside the new seal.

One final note on the input shaft: use very fine (1600 grit) emery cloth to polish the area of the area that mates with the front seal. This is probably a futile exercise because there is one thing that is nearly certain about Triumph seals --- they don't.

Mainshaft Rebuild

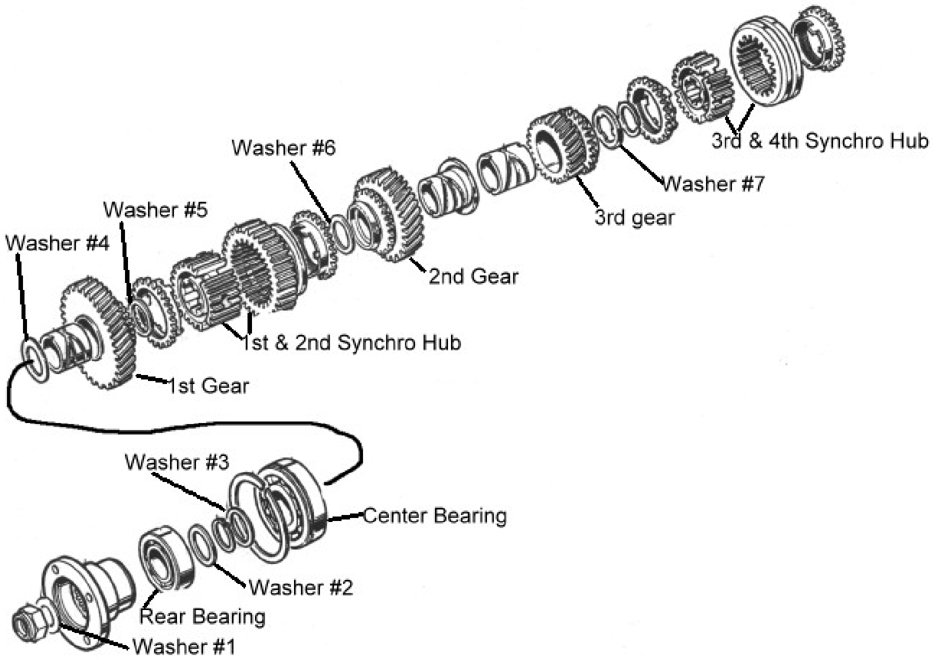
The first step in rebuilding the mainshaft is to remove all the gears, washers and bushings. The first speed gear and the synchro hub assembly for first and second speeds and the reverse gear together with bushings and washers are held in place by the center mainshaft bearing. The mainshaft was pressed out of this bearing in the process of removing it from the case. Hence, these parts are fee to slide off the mainshaft. These parts were wired together in the order they were removed to ease assembly later.

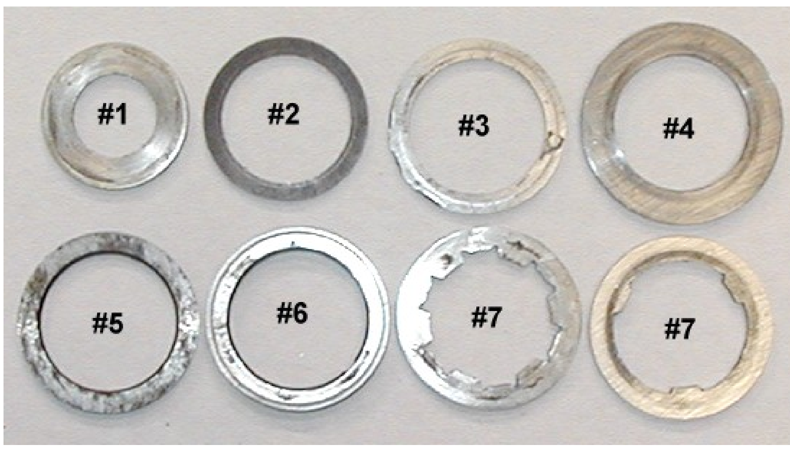
The third and forth speed synchro hub is held in place by the input shaft. This slid off the front of the mainshaft when the shaft was removed from the gearbox.

Second and third speed gears together with washers and bushings are held in the front of the main shaft by a heavy clip. To remove the clip, place the mainshaft in the vise (wrapped in a rag) and pry out the clip with a couple old screwdrivers. With perseverance, the clip will finally give up and come off. If you're lucky, you can get part of the clip out and break it in half which then eases removal. (There is a new clip in the overhaul kit.) Wire this set of parts together to ease reassembly. The gears together with the input shaft, mainshaft, and bearings are shown in the next photo.

Each part was inspected when taken off the mainshaft and all were OK except for the bush under the second speed gear. The end was broken off this bush that is also called a top hat bush. The following photo shows the broken bush beside the new replacement. This same bush was broken in the same way in both gearboxes disassembled. The TRF catalog indicates that this bush is very failure prone, possibly due to inattention to proper end float. (The later gearboxes were redesigned to use steel bushes instead of these brass bushes.)

Washers: Some months after this note was written I was working on another gearbox and managed to with mix up the washers. I then decided to examine each washer, photograph it, and document where it goes and it's size. The next to photos show the washers and locations.





	Description	ID (in)	OD (in)	Thickness (in)
#1	Between nut and rear flange	0.763-0.778	1.374	0.117
#2	Between rear bearing and shoulder on mainshaft	1.192	1.517-1.525	0.095
#3	Between circlip and center bearing	1.256-1.264	1.642	0.94
#4	Between center bearing and 1st gear	1.256	1.887	0.141
#5	Adjustment washer between 1st gear and mainshaft shoulder	1.257	1.673	See Text
#6	Adjustment washer between 2nd gear and mainshaft shoulder	1.257	1.688	See Text
#7	Splined, between circlip and 3rd gear	1.122	1.684	0.120

The photo above shows two versions of washer #7, the splined washer between the circlip and 3rd gear. These I believe can be used interchangeably.

A range is shown for some of the dimensions. Pete Chadwell measured a set of washers on his '73 gearbox and I measured a set from a '76 gearbox as well as a few from a TR4 gearbox. If all measured within a few thousands, I picked a number in the middle of the range. If the variation was greater than a few thousands, I recorded the range.

The adjustment washers come in a variety of sizes and are selected as required to achieve the required end float. For gearboxes before commission number CF12,500 (through '73 I believe) the washer selection for $5 and #6 are the same, a thickness range from 0.118 to 0.133 inches. For gearboxes after commission number CF12,500 washer # 5 has the same selection as before while washer # 6 is much thicker with a selection range of 0.197 to 0.208 inches. The later mainshaft that goes with this thicker washer had a small ball that sticks out under this washer and the washer has a cut out section to fit over the ball. I don't know whether the ball is to insure you use the right washer or is to keep the washer from turning.

Gear Float: (This section was rewritten on 10-14-01 to clarify the process.) The next job is to measure the end float between first, second, and third speed gears and their respective bushes. The process for 1st and 3rd gear is identical. The bush should be .004 to .008 inches longer the the mating part of the gear. One of the problems is to align the end of the bush with the recessed end of the gear. Pete Chadwell suggested that one set a synchro hub on the bench, place an adjustment washer (#5 & #6 above) on the top of the hub and then place the gear with bush inside on the washer. Next, one places the edge of a steel rule across the end of the bush and determines the end float by measuring gap between edge and the gear side with feeler gauges. This is shown in the left photo below. (Note that those nice fingernails belong to a visiting engineer. She learned about feeler gauges and calipers in this photo op.) The first and third speed bushes can be interchanged if required to get all within specifications. Reducing the length of the respective bush can reduce end float. If there is insufficient end float, the bush must be replaced. Fortunately, the end floats were within specs.

Second gear and the associated bush is also set up on the synchro hub & adjustment washer. However, the top hat brim presents special problems. The float is the gap between the underside of the brim and the gear side. Unfortunately, the side of the gear is recessed so it is difficult to get all except the thinnest of feeler gages to flex enough to get into the recess and under the hat brim. Pete Chadwell had a lot of trouble using the feeler gauges here so he suggested using the dial caliper as a depth gauge to measure the distance from the outside face of the hat brim to the gear side. Then take the gear off the synchro hub and let the bush slide all the way in and take a second measurement. The difference between the two measurements is the gear float. I tried this and it worked pretty well. I suggest you press down firmly on the bush when taking the measurements. Also, it is suggested that you repeat the measurement several times until you get consistent results. The right photo below shows the engineer with caliper.

I was able to measure the 2nd gear float using feeler gages for the new bush used in this gear box. Just before doing this update I obtained another new bush for a future project. This bush slid freely over second gear except for the last .050 inch or so. Inspection reveled that these was a slight raised edge beside the relief cut adjacent to the hat brim. I removed this edge with a small file and the gear then seated properly and turned freely. Unfortunately, there was no gear end float. The length of the cylindrical part of the bush that fits into the gear is about .006 inch shorter than that of a used bush I measured. I will have to trim the cylinder side of the brim on the lathe to make this bush usable.

Bush Float: The next job is to assemble the second and third gear bushes together with spacers, washers and clips on the mainshaft and then measure the bush end float. When attempting this using the new top hat bush it was found that the inside diameter was too small --- it would have to be driven onto the shaft. It was then recalled these bushes had to be driven off the mainshaft of both the gearboxes. It seems futile to measure end float when the bushes won't float. This may be why the top hat bushes are prone to break; they are supplied in the wrong size. The bush was mounted in the lathe and the inside honed with 300 grit Emory cloth just enough so that it could be pressed on the mainshaft by hand.

It was then possible to assemble everything and measure the end float as shown in the next photo. The front washer can be reversed and the back edge of the front clip can be slid into the grove for this measurement thus avoiding the difficult task of installing and removing the clip. The specs are for an end float of .003 to .009 inches. The measured end float was .010 inches ----- just a bit too much. The rear washer is an adjustment washer that is available in different sizes to adjust the end float. It looked like a thicker washer would have to be ordered.

To measure the end float on the rear (first gear) bush it is necessary to assemble the parts and then press on the center bearing --- see next photo. After this is done and the clip installed, the bearing should be pressed back so that it is snug against the retaining clip. The end float specs are the same as for the front bushes. In this case the end float was .003 inches --- at the minimum. The rear set uses the same type adjustment washer as the front set. Each washer was measured and the front one was found to be thinner than the rear one. Reversing the washers yielded an end float was about .007 inch on both. Note: the two adjustment washers, #5 and #6 above can be reverse only on pre commission number CF12,500 gearboxes.

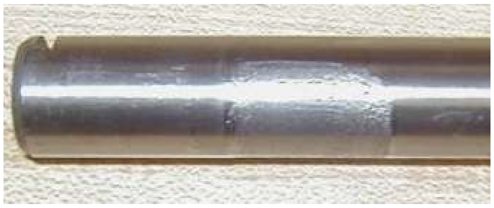
The next step is to assemble all the gears on the main shaft. The mainshaft is mounted in the vise and the front set of gears is slipped on together with washers, bushes, synchro cup, etc. The bushes should be lubricated with gear oil before installation. Next, that nasty clip is installed. (Three old screwdrivers were driven into the mainshaft groves to expand the clip and then the clip was driven on using a punch --- see photo.) Next, the shaft is set on the bench and the rear set of gears, synchro hub, bushes, washers, etc lubricated and slid in place followed by the front synchro hub and synchro cups. The rear set of gears and the front synchro hub are not held in place until the mainshaft is installed in the gearbox. Everything is wired together to ease the later installation into the gearbox as shown in photo.

Countershaft Rebuild

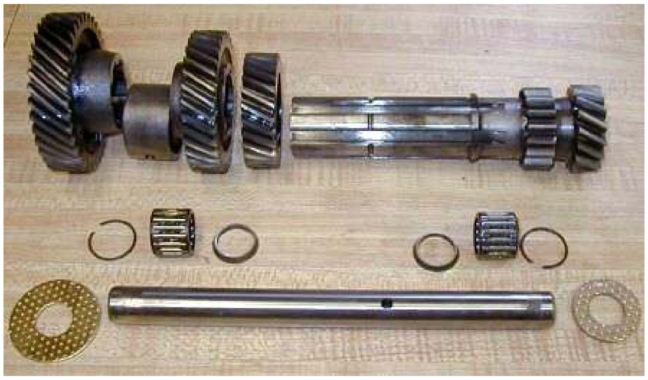
The major wear point on gearboxes is the rear countershaft bearing and the countershaft under that bearing. This is near the first speed gear that must endure the greatest forces, especially if one likes to ***peel rubber*** to impress the girls.

A few years back the gearbox in my '76 TR6 was making funny noises. Maintenance was deferred till the OD quit shifting. Upon disassembly it was found that the rear countershaft bearing had disintegrated with some of the pieces apparently getting into gears causing teeth to break. Some pieces made it into the OD unit hydraulic pump damaging the piston and cylinder. It took ~$150 worth of parts to repair the OD unit. The only thing salvaged from the gearbox was the mainshaft that was used in another late gearbox to assemble a working gearbox - J type OD combination. The moral of this story is to attend to a whining gearbox at once --- things will only get worst if not attended to (the same can probably also be said about a spouse).

In the two gearboxes disassembled for this project, one countershaft was good and the other was heavily worn as shown in the next photo. A countershaft with any sign of wear should not be used --- pay the ~$30 for a new one.



The next step is to remove the clips from the end of the countershaft assembly, remove the bearings, slide in new lubricated bearings and reinstall the clips. Since the later of the two assemblies is being used here, the bearings fit without removing the beveled washers on the inside of the bearings. The countershaft parts are shown in the following photo. The large washers with holes are thrust washers (new ones supplied in the overhaul kit) installed at each end of the countershaft gear assembly.



We finish the job in Part 2.

Other Notes on TR250-TR6 Gearbox: Disassembly